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CHAPTERS FOR A BIOLOGICAL EMPIRICAL PSYCHOLOGY

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CHAPTER IV

INTROSPECTION.

Consciousness of organism given, multifarious forms assumed follow on dynamic principles laid down. Source of knowledge of consciousness. Solution of introspection problem. Observ-ed and observ-ing consciousnesses; former on same plane of objectivity as "external world." Homology of relations of both consciousnesses to (1) thermoid energy; (2) nervous rhizome; (3) object of observation. How mental states become known in introspection; how become indefinitely composite. Scope of introspection. It is superfusion content; its radius of validity that of consciousness in general. Mystery of mind a phase of problem of being. Evolution of introspection. Latter one of many names for thought.

Whereas chapters I-III[1] deal chiefly with *process* and secondarily only with content, coming chapters are largely concerned with elucidation of mental phenomena on basis of the dynamic principles enunciated, with showing that *consciousness of the organism given,* the rest follows, as of necessity, on those principles. That is, alike the kaleidoscopic forms assumed by that consciousness and the momenta contributed to process, are given between the increment-to-increment correlation of consciousness with thermoid energy, and the reactive effect of that energy upon substrate,—"process" meaning the psychodynamic, and denoting all the concatenated changes coming about in, or reactively wrought upon nerve substrate, in connection with transit of nerve energy from sensory to motor.

Text: You mustn't impugn the validity of consciousness, for in the act of impugning you assume that validity; all my knowledge comes to me through my consciousness and I know *it* first and best and your "external world" only secondarily and through it,—etc.

Raising many questions, but no problem of the metaphysical order seen in them by philosophers and none not amenable to the methodology of science.

Source of knowledge of consciousness.—Consciousness is said to be directly experienced, and knowledge of it, therefore, immediate and irreducible. But *that* consciousness which is *known,* stands with reference to the consciousness which knows it (the introspecting consciousness), on the same plane of objectivity as the "external world." For, only as consciousness comes to be introspectively observed, does it become known. For proof, let one see how much (rather, how

[1] *Amer. Journ. Psychol.,* 1909 (Jan.), XX, 60-106, to which all references 60-106 relate.

little) he will get on trying to observe the observ-*ing* consciousness. Whence, "consciousness" here covering two things differently relationed, the observ-*ed* consciousness and the observ-*ing* consciousness, confusion will be avoided by terming the former *psychosis,* the latter *introspectio.* These different names do *not* imply any difference in process; for in psychosis and introspectio alike (1) consciousness emerges with supraliminal value of the relation between nerve energy and resistance; (2) relations of both to the nerve substrate are identical, both budding off (so to speak) from the nervous rhizome, laterally, discretely, without serial interconnection, like successive flowers of *Polygonatum* (Solomon's Seal); and (3) in both, the relation of the observing consciousness to the object of its observation, is identical. For, psychosis includes *as content,* consciousness-values representative of the "external" object, not because psychosis is aroused *directly* by that object, but because nerve-energy waves initiated by the latter, turn out (on emergence of psychosis) to involve *de facto* those particular consciousness-values. And similarly, introspectio includes *as content,* consciousness-values representative of psychosis, not because introspectio is aroused *directly* by psychosis, but because nerve-energy waves demonstratedly possessed of psychosis values, being prolonged into the superfusion focus, introduce into the superfusion content, those same values. Which shows (1) that introspection is a state of consciousness in which another conscious state becomes known through emergence as part of the composite introspection-content (introspectio); (2) how, generally, one content includes other contents and content becomes indefinitely composite; and (3) how, particularly, present-moment content includes past content (memory-images, experienced relations), the re-emerged part-content differing from its former emergence only in its fusion with present-moment content-constituents (recognition of present experience as re-experience, etc.).

"My" only source of knowledge *of* consciousness, is, then, introspection. But before I can come to understand the nature of, and the relations involved in the content revealed, I must ascertain the extent to, and the accuracy with which introspection is capable of mirroring forth that content. These first appear when we inquire what introspectio is,—*entity, process,* or *content?* It is superfusion content,—"superfusion" including super-super-(etc.) fusion.

Limitations of introspection.—Though facts prove association of consciousness with brain, introspection affords no hint of such association,—exploding the fallacy that introspection giving no hint of a condition, is evidence that the condition does not obtain.

As superfusion content, introspectio includes consciousness-values representative of the waves undergoing superfusion, minus values corresponding to interference-reduction. These waves fall into a series incoming from the sense-organs, and a series reactive thereto. No more, then, will introspectio mirror forth intimation of brain in absence of a brain-appreciating sense-organ, than psychosis in a congenital amaurotic include visual ingredients; *equally with psychosis,* introspectio mirrors what comes into it, nothing more.

What, now, is the "*mystery* of mind?" It is not introspectio; no

mystery attaches to it that does not attach equally to psychosis. Nor yet is *the* mystery, the consciousness of the organism; its consciousness and its wetness are, as critical phenomena (see below), alike and equally, *both or neither,* given *in posse* in the original substance. The mystery is not even that molecular activities occasion the properties of bodies[2]; *that* clears up as soon as we write *all* the terms in the dynamic equation (critical sequence), when we see that the molecular activities *are* the properties. These, then, are but so many *sub*-mysteries, to be merged in the Great Mystery, the *Ultimate*-Philosophic problem of being.

The "mystery" is, at any rate, not *mind; consciousness of the organism given* (and for psychology—likewise Penultimate Philosophy —it is empirical fact), the rest follows.

As no conscious state is analyzed (introspected) in itself, no introspectio affords evidence as to its own compositeness. Such evidence would first accrue via some super-introspectio into whose super-composite content entered, along with relational content expressive of difference, the introspectio as part-content. But from failure of attempts at introspecting the introspecting consciousness, it is more than doubtful whether (1) such super-introspectio exist; and (2) if it exist, it would afford evidence as to compositeness, since, in general, it is in cases of association rather than of fusion, that upon introspective observation, content becomes discriminated into discrete states.

Equally with psychosis, introspectio mirrors impartially all that comes to it,—my diplopia and "normal" hearing ingredients alike. Whence, its radius of validity is that of consciousness in general, of which, in the human, the introspectio (higher fusion) type forms by far the greater part. And introspective observation differs in no wise from observation in general, the essence of which is: Emergence of consciousness-values representative of the object, equally whether that be an "external thing," or a mental state.

Finally, introspection is but one of many names for thought, according to differences in its orientation,—intra-oriented, introspection; mono-oriented, attention; retro-oriented, memories; un-oriented, imagination. Fused with feeling ingredients,—more names: Concentratedly oriented, emotion; tinged or dominated by erotic equivalents, day-dreaming,—etc. Mere *content*-names, these do not imply difference of *process,* to which they have no reference, "mental *process*" being myth, as successive mental states have no interdependence.[3]

[2] L. F. Ward (*Status of the mind problem;* Spec. Papers Anthropol. Soc. Washington, 1894, No. 1, p. 13): "The great mystery is not merely that 'brain processes occasion knowledge,' . . . but that molecular activities should occasion any of the properties that bodies possess. It is not mind alone, but matter also and equally, whose ways are beyond our powers." But are we so ignorant of forces, properties, causes? Positivists insist science progresses solely through study of phenomena and their laws, Comte holding cause and effect mere succession. The stress on laws, however, contains admission of all one need claim, that the succession is *orderly, uniform, invariable, absolutely dependable.* But this is what cause and effect *mean;* when this orderly succession is known, the proximate causes are known. Not less is this true of the rigidly fixed and invariable relations of brain-states to states of consciousness. The former are "the uniform antecedents and true proximate causes of the latter, and so far as we know these relations we really know the cause of mind."

To this paper I look back for my first insight into philosophic perspective.

Evolution of introspection.—Introspection evolved incidentally; what is now an introspection, was originally a reaction inhibitive-regulative fusion-focus, the essence of which is substrate upon which entrant and reactive waves simultaneously impinge to summated crests or interference-reduction. But, in such a "superfusion-focus," the dependent content will, *as inevitable incident,* include just the introspectio consciousness-values,—values representative of the waves undergoing superfusion, minus values corresponding to reduction.

CHAPTER V

I. Continuity a myth. Discontinuity of two kinds. Philosophy of Critical Phenomena; sudden emergence de novo of qualitative incommensurateness, indicates critical phenomenon, not new order of being. Everything apparently existent in posse in original substance. In philogeny and ontogeny, consciousness appears with advent of critical conditions.

A unity ("thing") an aggregate unified via critical sequence; has existence distinct from constituents,—as mechanical system with dynamic values the algebraic sum of all forces concerned in its upbuilding; neither has nor is, but becomes its properties in becoming itself, properties and constitution emerging synchronously as a function not of properties and constitution of constituents alone, but equally of all factors entering into formative sequence.

Progressive unification to atoms and molecules, of parent-multiples, at successive critical junctures. Structurally similar compounds, inorganic and living alike, exhibit similar properties because similar composition has entailed similarity of formative sequences.

From the beginning dates not consciousness but *genetic*-ness. Bodies arising via identity or equivalence of critical sequence, living-matter aggregates (organisms) arise only via identity, because passage through ancestral sequence-cycle results in assumption of ancestral characters ("heredity"). Theory of anabolism.

II. Mental fusion an imbrication; always intramental,—but interference-reduction always intraneural. Fusion mainly serial.

Mental states classifiable in two systems, with different criteria and canons of evidence,—as single or plurual; simple or composite. Of compositeness introspection affords no indication; diagnosis possible only through knowledge of derivation. Mental units the briefest states appreciable. Successive mental states not interdependent. The consciousness lasting many sigmas consists of independent concurrents; the sigma consciousness, of independent concomitants (cross-sections of concurrents). Congruity of states mainly serial; a function of neural congruity.

Unit of brain-activity underlying mental states, activity of small related neurone-groups.

What constitutes fusion-substrate? Brain sufficient substrate for fusion of all mental states or else of none.

Summary of chapters I-V. Penultimate Philosophy knows no ad infinitum. The primordium its limit because there its methodology ceases to apply. If electrons prove ether-derivatives, this philosophy reaches its finality with a de facto unitary universe.

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[3]The most important term in science but as used in psychologic literature the emptiest, is *process,*—see any page, where *everything* is it, *e. g.* "process of memory," whereas memory is *mental fact,* outcome of process, not process itself. What should be said is: Process *underlying memory.*

I. Philosophy of Discontinuity.

James's chapter, *The Mind-Stuff Theory*[4], consists of three main contentions: Mental states are not composed of lesser states conjoined (146-158); fusion of such states is always intraneural, never intramental (158-162, 178-182); unconscious mental states do not exist (158-178),—with the last of which we are in accord.

Thesis. (*a*) Evolution is *continuous,* ergo no factors not present at the beginning, are introduced later; (*b*) consciousness seems a "new nature" whereof the potency was not given in the original "outward atoms."

> In evolution, "no new natures, no factors not present at the beginning, are introduced at any later stage. But with the dawn of consciousness an entirely new nature seems to slip in, something whereof the potency was not given in the mere outward atoms of the original chaos. The enemies of evolution have been quick to pounce upon this undeniable *discontinuity.*" Evolutionary enthusiasts talk as though mind grew out of body in a *continuous* way. "So strong a postulate is *continuity!* . . . And consciousness, however little, is an illegitimate birth in any philosophy that starts without it, and yet professes to explain all facts by *continuous* evolution. If evolution is to work smoothly, consciousness in some shape *must have been present at the very origin of things*" (I, 146-149),—italics ours.

Comment.—Waiving the question whether discontinuity represents a periodic function of an ultimate inaccessible continuity, continuity as ordinarily understood, is myth.[5] Of nothing in the universe can it be asserted unless of ether and consciousness. To the physicist with the ether; the only developed theory as to its *nature* (Mendeleeff's), supposes it discontinuous. And the evidence is that consciousness, *in forma* mental states, is an imbricated pseudo-continuity.

Everywhere, *de facto,* discontinuity reigns; but the term covers two different conditions:—

Discontinuity: Increase in matter, energy (including consciousness), extension, duration (etc.), by increments or larger amounts (and, *mutatis mutandis,* for decrease); magnitude of result in keeping with magnitude of final determinant of change (successive expansion-differences with successive temperature-differences); result differing only quantitatively from, and predicable through knowledge of antecedent conditions; advent of change more or less *gradual,* in keeping with magnitude of final determinant. Type: Expansion of bodies.

Critical Phenomena: Phenomena coming about *through interaction* of forces proceeding beyond equilibrium and involving *change of "state;"* magnitude of result more or less and often absurdly out of keeping with magnitude of final determinant (powder explosion

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[4]*Principles of Psychology,* 1890, I, 145-182. Here is cited practically all *evidence* (including argument), but comments upon opponents and mere illustration are omitted, as not evidence. James's theses are formally stated.

I analyze this chapter because it lies in my way; it is the most direct attack I have met, on compositeness of mental states, which compositeness I believe to lie at the root of a scientific psychology; it illustrates logical-metaphysical methodology, contrasting with the fact-methodology of science; and, discussing problems most writers shirk, its theses afford texts for constructive theory.

[5]The "law of continuity" is not myth but misnomer; there is no continuity, only *unfailing succession.*

"Continuity of the germ-plasm" is similar misnomer. Whatever the nature of the phenomena included, there is discontinuity everywhere,—cell-divisions innumerable, histologic differentiations, etc.

from match); result differing qualitatively from, and not predicable through knowledge of antecedent conditions (known only through actual experience of critical sequence); advent of change more or less and often quite *sudden,* bearing no assignable proportion to magnitude of final determinant. Type: Liquid state,—where, with water vapor, neither cooling alone nor pressure alone suffices to bring about liquefaction, above the "critical" temperature no increase in pressure, however great, sufficing, and below the "critical" pressure, no reduction in temperature, however great, sufficing.

Instances: Transition from rest to motion, breaking strains; solution, precipitation, crystallization, ebullition; atom formation, chemical combination and decomposition, probably the living and apparently the conscious state,—are a few, critical phenomena embracing every case of interaction proceeding to transit across equilibrium. In such cases it suffices to say: Critical phenomenon between (such and such forces); and such phenomena are as fully known as is possible, when *all* the antecedent and consequent conditions entering into the critical sequence are precised, and the quantitative relations on both sides of the critical equation, determined. But our knowledge embraces one other fact: The critical conditions given, the critical change *invariably follows.*

Especially does the living state afford instances: Egg-fertilization, mitosis, color (and perhaps sex) determination, variation, menstruation, parturition, moults, heart-beat, reflex action, deflections in nerve-energy flow, etc. It is because of its richness in critical phenomena, that the living state affords so many surprises.

Never antedating the critical conditions (come those in whatever order happens to obtain in cosmic evolution), critical phenomena *are just* factors not present at the beginning but introduced at a later stage; in keeping with suddenness of advent of the critical conditions, they appear suddenly; the result is qualitatively incommensurate with antecedent conditions. Before, then, a condition newly appeared is pronounced a "new nature," either it must be proven *not* of the critical order, or affirmative presumptions be drawn from considerations *other than* previous non-existence, suddenness of emergence, and qualitative incommensurateness with antecedents. But every known instance of a condition incommensurate with its antecedents, arising suddenly *de novo,* being of the critical order, in a doubtful case presence of this combination of characters, raises the strongest presumption that that case too is of that order,— and, in particular, that consciousness is. And no contention that the latter is a new nature whereof (etc.), will hold in absence of either successful destructive criticism of the conception Critical Phenomenon as here generalized, or proof that consciousness is a phenomenon not of the critical order.

In the course of terrestrial evolution, there have appeared, *inter alia,* four conditions offering the critical combination of characters: The liquid state of matter, its colloid state, its living state, its conscious state. When, now, globe-temperature came to reach the critical, the hyperthermophile philosopher of that time would say: "This is *new;* it is *wet.*" But, if he add: A new nature, and (worst of all) whereof the potency was not given in the original atoms, he would find no warrant in Penultimate Logic. For (1) all we know as to what potency was or was not given in those atoms, is what we see unfold out of them; and (2) assertion that anything which *de facto* unfolds, did not unfold out of *them,* is sheerest gratuity in absence of indication from what other source it did unfold. And

though with a new nature as with a miracle, what evidence suffices to establish the contention is an undetermined quantity, of that evidence, at any rate, sudden emergence *de novo* of qualitative incommensurateness, forms no part.

But that potency of the liquid state (likewise of the colloid), was given in the original atoms, is everywhere admitted. Assertion, then, that the potency was not equally given in the case of the living and of the conscious states, should be supported by evidence establishing a line of demarcation between the two sets of cases. And pending such evidence, logic which relegates consciousness to the very origin of things, must equally so relegate *aquosity,* and *colloidosity,* and *vitosity,—regressus* to everything that modern science supposes *not* to exist *in esse* but only *in posse* in the original substance. And the way *esse* emerges from *posse,* is via critical sequence.

Critical phenomena are the veriest of *de facto* sequences, abounding in *outre* contiguity-associations to the outreness of which habituation blinds us, with the result that our "qualitative" differences are largely arbitrary and traditional. In sensible characters, *è. g.,* the electric disequilibration consequent upon rubbing glass, has *no more* in common with the rubbing or the glass, than consciousness with nerve energy or resistance. True, faced by the actually experienced following of disequilibration upon rubbing, we *try to conceive* some element common to (common feature in) antecedents and consequent, and believe we find it in *motion.* Thus we organize (*not* create) our universe by progressive ejectivation of categories which invented to harmonize seemingly discrepant *sense-data,* are *never wider than those data.* But if a common element can be conceived between conditions sensibly so diverse as all known antecedents and all known consequents, there is no valid reason from the *qualitative* standpoint, why such an element should not be conceived between consciousness and energy. Our strongest reason, however, for holding the various energy-forms fundamentally one, is *de facto* and *quantitative,*—their interchange, at constant "equivalent." Had we, now, a consciousness-appreciating *sense-organ,* we should have elaborated an explanatory category wide enough to include harmoniously consciousness and energy (as larger multiples include smaller); for, we should have been able to determine *directly* the consciousness-energy equivalent, as now that for *sense-accessible* energies. But absence of such organ entails the consequence that *even if* consciousness *be* energy, proof must be indirect, *without, however, the case for identity being thereby compromised.*

Non-extension is either *criterion warranting* separation of categories, or mere diagnostic mark of categories *already tacitly assumed* distinct. If the latter, distinctness remains to be proven; if the former, I deny its sufficiency. The *real* question is: Does consciousness interchange with energy? Here, all we *know* is: (1) In one form (sensation), it arises *seemingly* on a *logarithmic basis of equivalence;* (2) in another form (thought), *seemingly* on an *inconstant basis* (progressive lapse). Any theory of identity must account for these facts of relation, fatal to linking of consciousness with nerve energy "as convex and concave."

Cosmic distribution of consciousness.—For a Penultimate Philosophy of consciousness and of evolution, the hypothesis of "aboriginal atoms," is needless, profusion of hypothesis, explains nothing, and is out of harmony with facts, breaking down the moment its consequences are deduced. Who takes *seriously* such atoms linked with vegetable atoms,—if so linked, where's the evidence; if not, when and especially *why,* consciousness being so very important, did they become unlinked? Where is the consciousness of the consciousness-atom in embryo (spermatozoon, ovule), and why are such atoms linked only with brain and not equally with toe-nail atoms? Can *they* become *unconscious* and in all degrees,—if *yes,* what does "atom of *consciousness*" mean; if *no,* what becomes of them when consciousness lapses? How do they sum to Fechner's logarithmic formula, etc.

In accord with the evidence and lack of it, our theory states cosmic distribution thus: No evidence warrants and no need, psychologic or philosophic, exists for asserting that consciousness antedated the advent of living matter[6], or that it has been coextensive with such matter; no evidence attests its presence on the vegetable scale; on the animal, it arose when progressive integration of structure came to involve the critical condition, and in embryogeny it arises when such integration involves such condition. But, Where It was *before* Its advent, What It was prior thereto, and similar conundrums, whatever they may be for Ultimate, are for Penultimate Philosophy what Christianity was for the Greeks, as sensible as Where or What was any other Critical Phenomenon before it occurred,—Where and What are Children, before conception; was Water when all was yet steam, before globe-temperature fell to the critical; Heat, before electricity passed against resistance? Of such cases, one can say only: (1) That at certain critical conjunctions, conditions, alike of matter and of energy, emerge at expense of ("out of") pre-existent conditions, is mere *empirical fact;* (2) it is *with their emergence, that our knowledge of such conditions begins.* And the evidence is that electricity and nerve energy "become transformed" in a way as unknown as everything else, the one into shorter "heat" waves, the other into longer "thermoid-energy" waves with which goes, merely *de facto,* consciousness.

RELATION BETWEEN A BODY AND ITS PROPERTIES.

Thesis.—"Things" do not exist, they are but names for the combined effects of their constituents upon our sense-organs.

"Atoms of feeling cannot compose higher feelings, any more than atoms of matter can compose physical 'things!' The 'things' for a clear-headed atomistic evolutionist, are not. Nothing is but the everlasting atoms. When grouped in a

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[6]Clear-sighted evolutionary philosophers begin to posit it in the nebula,—aboriginal atom linked with each material atom. *As* these atoms aggregate to brains, *"by an analogous process,"* consciousness-atoms fuse to larger consciousnesses which we know in ourselves. "Some such doctrine of atomistic hylozoism as this *is an indispensable part of a thorough-going philosophy of evolution.* According to it, there must be an infinite number of degrees of consciousness" (I, 149),—italics ours.

Comment.—Sample of difficulties simplified away by philosophy of critical phenomena. If *logic* govern and consciousness go to the nebula, *aquosity* must go too, and every other-*osity*. But, pending proof, consciousness in nebula, its infinite number of degrees, and the analogous process of aggregation, must, as profusion of hypothesis, rank as non-existent.

certain way, we name them this 'thing' or that; but the thing we make has no existence out of our mind" (I, 161). "Let it not be objected that H_2 and O combine *of themselves* into 'water,' and thenceforward exhibit new properties. They do not. The 'water' is just the old atoms in the new position, H-O-H; the 'new properties' are *just their combined effects* when *in this position*" (I, 159),—italics ours.

Comment.—This thesis James introduces incidentally, but it raises questions too fundamental and too closely linked with the philosophy of critical phenomena, to be passed over.

Bodies ("things") exist, as *mechanical systems,* whose effect-making dynamic values ("properties") are the algebraic sum of *all* forces to which in their discontinuous upbuilding, the constituents have become subject. A body neither *has* nor *is* its properties, but *becomes* them *in becoming itself* (structurally).

As fact, H_2 and O do not combine to steam, of themselves, but only in presence of certain ether waves ("heat waves"). The "act" of combination involves two complementary conditions,—evolution of "heat of combination," coincident volume-compaction. But steam is not water; between the two lies another (cooling-pressure) critical sequence, involving evolution of "latent" heat and volume-compaction. The "new properties" are, then, not the "combined effects" of H_2 and O, but the effects of H_2 and O *combined,*—which is what "in this position" *means,* the only way they *get into* this position being via the two sequences. For, whatever prove to be the law relating the properties of a body to the properties of its constituents, it is certain that the former properties are a function not of the latter properties alone, but *equally of all factors entering into the formative sequence,* —of evolved heat and volume compaction, as of H_2 and O. Only a combination forming from the mixed gases *without dynamic change* (with neither liberation nor absorption of heat) could have properties the "combined effects" of the constituents. But, this is just the condition under which *combination* does *not* take place,—only *mixture;* and the properties of the mixture H, H, O, *are* the combined effects of the ingredients. Where a body arises via plurality of sequence, its properties are a function of all factors entering into all sequences passed through.

On the same side of a critical sequence (between successive sequences), properties form, in general, uniform series; nevertheless in such series, properties exist *for bodies capable of appreciating them.* For, the same body exerting different effects upon different other bodies (water dissolving salt, not barium sulphate; camphor delirifacient in man, paralyzant for frog), "property" is *two-relational,* including: (1) In the property-possessed body, specific effect-making dynamic values; (2) in the body with reference to which the property exists (property-appreciating body), *property-susceptibility.* With homocentric assurance in keeping with his intoxication-philosophy, man habitually thinks of properties as effects *upon himself;* but such effects are merely special instances in a wider category, and the subjective-objective antithesis finds an homology of relations wherever property exists. Thus, the for us uniform 100°-upward steam series, is for CaO (quicklime) broken into two: Below redness, an affinity series; above redness, a no-affinity series. Whence, if conscious CaO would

say: "Below redness, steam cools me, slakes my thirst; above redness, it is *hot,* I cannot take it." Especially has the physically uniform 100-4° water series[7] become differentiated for the habitant organisms into a "hot" and a "cold" series, via developing psychogenic susceptibility as starting-point of "protective" reaction. But such differential reaction to uniform series is no exclusive possession of living matter; it is only more frequent and apparent in it, because it is matter in which modifications resulting from environmental contact, *continually become summed.*

Given, now, temperature above the dissociation-point of the most refractory atom, the universe would consist of ether and electrons only. Upon decline in temperature below such dissociation-point, electron-unification to this type of atom-unity would ensue till, we may assume, mutual repulsion of the newly forming atoms balanced the atom-forming forces. Below this temperature, it is only fact (evidenced in the periodic law) that further unification does not ("cannot") come about till the dissociation-point of the next most refractory atom is passed, when formation of this atom-type ensues to equilibrium,—etc. And subsequent fall in temperature below the various molecule dissociation-points, results in atom-unification to molecule-unity after molecule-unity. Thus, progressive temperature-decline across successive critical points, involves formation of all bodies as *critical* discreta. Several corollaries follow:—

1. Aggregates are of two kinds. *Aggregate*: A collection of unities; properties, the algebraic sum of the properties of the collected units. Example: Mixture of gases (H, H, O).

Unity: An aggregate *which has been unified* via critical sequence; properties, a function of all factors entering into the formative sequence. Example: Chemical combination (H-O-H).

2. Structurally similar compounds (chlorides, congeners) exhibit similar properties because similar composition has led to similarity of formative sequence. And it is inference that where in such compounds, divergences occur (insolubility of $AgNO_3$ and $PbCl_2$; aberrant species of a genus), explanation is to be sought in some anomaly of critical-sequence relations ($PbCl_2$ dissolving in boiling water, vaporization of solvent may occur below solubility-temperature for $AgNO_3$).

3. Philosophically most important is the fact that at the origin of things begin the vertical *genetic descent lines,—genetic* denoting that progressive complication, alike and equally in structure and properties, everywhere coming about through unification of parent-multiples (electrons) to a daughter-unity (atom), of daughter-multiples to a granddaughter-unity (molecule), etc., in such wise that structure and properties being a function of the factors entering into the formative critical sequence and those factors including the structure and properties of the constituent multiples, the structure and properties of each granddaughter (great-granddaughter, etc.) unity are a function of the structure and properties of the several daughter-multiples, consequently a function of the factors entering into the daughter-formative critical sequence, consequently of the structure

[7]Reversal in the contraction series at 4°, perhaps means incipient crystallization; cf. J. G. Adami, *Harvey Society (N. Y.) Lectures,* 1906-07; Adami's citations refer, however, only to lipoid substances.

and properties of all the parent-multiples,—*regressus ad indefinitum et initium.*

As with the current conception, genetic as here widened, refers solely to the synthetic side of chemical action, but includes, as similarly relationed, all bodies on that side.

4. Characters arising via critical sequence and further characters only via further sequence, "differentiation of characters" is a poor phrase considering that the process is *integrative* and consists in *superaddition* of sequences on to the sequence-cycle leading up to the stage from which "differentiation" starts. This is *why* development is "from the simple to the complex, the general to the special." The complex and special arise as a *further-carrying* of the critical-sequence cycle terminating in the simple and general. In this genetic sense, *Universalia ante rem* represents fact.

This *acrogenous* character-endowment explains why (1) specific (varietal, etc.) characters come last in the embryologic record; and (2) characters tend to progressively earlier emergence in that record ("law of acceleration"). And later I shall try to explain abbreviation of the record as the outcome of secondary modifications of the critical-sequence relations of the heredity (identity) cycle.

5. Though in the beginning, bodies possessed of identical properties originated via identity of critical sequence (water via chemical-combination cooling-pressure sequences), now that conditions are below certain sequence limits (cooling-pressure limit), some bodies arise via either identity or equivalence of sequence (water via two sequences or interaction of sulphuric acid and alcohol). Pathognomonic of living-matter aggregates (organisms) is, however, origin only via identity of sequence. Why this difference *in behavior?* Only matter can "live," which is possessed of capacity for adequate response to environmental happening, which means capacity for (1) more efficient response to subsequent energy impacts than to the initial impact (profiting by experience); and (2) summing, from generation to generation, of the "acquired" profiting modifications. These capacities meet in matter possessed of *plasticity*, in which matter summing comes about indirectly, *via the identity-cycle.* For (1) individuals possessed, *de facto,* of *Anlage* optimum in plasticity-interrelation (93), profiting best by experience, survive in disproportionate percentage to breeding; and (2) their spermatozoon and ovule molecules in passing through a critical-sequence cycle identical with that through which the corresponding parent-formative molecules passed, take on, successively and progressively, the parental characters[8] including the optimum of interrelation (developed later as a theory of heredity including organogeny). Whence, results indefinite perfection of plastic *Anlage* with consequent illimitable possibilities for profiting by experience[9]. And here we find one reason for association of lengthening of the somatic cycle (especially its pre-

[8]J. A. Ryder (*Woods Hole Lectures* for 1894) recognized that embryonic structures arise only through *interaction* of *Anlage* and environmental energies, via critical sequence, *i. e.* Regarding his law: *Repetition in heredity is conditioned upon repetition in environment,* as near the fundamental ontogenetic formula, I shall extend it to all structural, to functional, and to mental development.

[9]To the something-from-nothing formula, "Function determines structure," this philosophy opposes: *Structure is exemplified in function.* "Function" and "structure" are but names, special in the supposed special case of living matter, for properties and constitution. But properties being the specific dynamic values inhering in constitution *qua* constitution, function is nothing but those values *immanent* in *already existing* structure, and so far from "determining" (antedating and giving rise to) that structure, is *fully* accounted for by it.

puberty portion) with growing preponderance of learning anew in each generation and accelerated evolution. For, rise of plastic *Anlage,* means *immediate* trying (in the individual lifetime) of the efficiency of that *Anlage* in action.

6. Food becomes built up to living matter, via super-added life-endowing critical sequences. For (1) in embryogeny, non-living matter thousands of times the original ovum substance, becomes transformed to the living condition; and the matter so transformed at each stage (each critical-sequence horizon), thenceforward partakes *equally with the original ovum substance,* in all subsequent critical sequences, to the same end-result,—integral part in the histologic elements. But if in the *n*—1, *n*—2, *n*—3 (etc.) developmental stages in which the process is known, character-endowment of this originally non-living matter comes about demonstrably via critical sequence, it is inference that in the remaining 1, 2, 3 (etc.) stages in which the process is yet untraced, such endowment comes about equally via such sequence. (2) That a substance built up via critical-sequence cycle represented by the stem and right limb of a *Y,* become transformed to one situated up the left limb, it must (by way of corollary) first become reverted back along the sequence cycle at least as far as the junction of the limbs,—whence, according to prevalent conditions, it may, via super-addition of sequences, become anything further, and, in particular, the substance up the left limb. Concretely, that hog, mollusk, or crustacea albumin become human albumin, the hog (etc.) albumin must be reverted at least to the hog-human junction. But physiologic economy precluding special digestive process for each albumin, the albumin-digestive process evolved, does revert all albumins beyond all junctions,—to pre-albuminoid, but still large-proximate albumin constituents.

7. At least to the extent that "quality" denotes *sensible property* (blue), it is an xy, consequently vanishing with x (seeing subject). But this vanishing consequent upon *vanishing of one factor,* proves neither that xy inheres solely in x, nor solely in y (blue "object"); it inheres in a result *of their interaction,* the thermoid-energy wave. Least of all does such vanishing of xy prove that y will vanish (along with x); it would only if a function of x. But later I shall try to show that consciousness is comprehensible only upon supposition (1) that a Something-else exists; and (2) it is a function of that Something-else. What is in y is not the "quality," but the environmental quality-making factor (dynamic value specific for y).

II. Fusion of Mental States.

Quoting Spencer that sensation of musical tone is compounded out of that of noise frequently repeated, James contends:—

Thesis.—Fusion need not be assumed intramental; it is never so, but always intraneural.

We do find the musical "note simple and continuous while the cause is multiple and discrete. Somewhere, then, there is a transformation, reduction or fusion. The question is, Where?—in the nerve-world or in the mind-world?" Without experimental proof, if decide we must, analogy and *a priori* probability can alone guide us (I, 154-158). A pendulum struck, swings back; but increasing force numerically does not increase effect, the pendulum not swinging at all. Blow through a tube, getting a musical note; increased blowing increases loudness only for a time, the note suddenly being replaced by its higher octave. Turn on gas slightly to tiny flame; more gas increases flame with a limit beyond which it becomes a ragged hissing streamer. Shocks through a frog's gastrocnemius, induce twitchings; more frequent shocks do not increase frequency of twitchings, but

induce continuous contraction (tetanus), the true analogy of what must happen between cell and sensory fibre.

"It is certain that cells are more inert than fibres, and that rapid vibrations in the latter can only arouse relatively simple processes or states in the former. The higher cells may have even a slower rate of explosion than the lower, and so the 20000 supposed blows of the outer air may be 'integrated' in the cortex into a very small number of cell-discharges in a second . . . some rather massive and slow process of tension and discharge in the cortical centers, to which, *as a whole,* the feeling of musical tone . . . *simply and totally corresponds*" (I, 156).

Comment.—Here, appeal to Philip against himself, suffices: "In every sphere of sense, an intermittent stimulus, often enough repeated, produces a *continuous sensation. This is because* the after-image of the impression just gone by *blends with the new impression coming in*" (I, 645). The "continuous sensation" is, then, composed of the "after-image" *blended with* the *"new impression."* But the after-image is *already-emerged* sensation, incapable of reverting back to its pre-mental neural state, to undergo fusion "in the nerve-world," with the neural antecedent of the similarly already-emerged new impression. If this does not mean fusion of sensations *as such,* what does it mean?

James will, to be consistent, endorse our explanation of the case he does not cite,—that when a green quadrant is rotated till "continuous" green results, the resulting pseudo-continuity comes about because (1) a certain *time* is required for a sensation to fade out; and consequently (2) with rotation become so rapid that the quadrant is replaced in the prime position before the sensation arising from its former presence there has faded out, the left-over previous sensation (after-image) "blends with" the newly aroused sensation due to its second presence in the prime position. Which *means*: Sensations *as such* do fuse; and further indicates *how* they fuse, by overlapping (imbrication) to the point of indistinguishability upon introspection. Whence, "continuous (single, individual) mental state" has no other meaning than: A mental state which, upon introspection, is not separated off from succeeding identical states, by emergence of a distinguishably different state. Or, concretely, so long as in introspectio, emergence of "one" green part-content is separated off from emergence of the "next" green part-content, by emergence of an intermediate not-green part-content, so long does the introspectio "I" pronounce the greens plural and successive; but when the duration of the separate-making not-green content shortens up to vanishing (non-emergence), then, successive greens become "continuous," merely because the pseudo-continuity is no longer perceptibly broken up.

Also, James will say that when complementary colors are rotated, the resulting white is an altogether different mental state, an entirely new psychic fact, etc. But, given such colors with brightness components ra and rb, nerve-current strengths will be $\sqrt{a}$ and $\sqrt{b}$. If, now, fusion occur "in the nerve-world," the combined brightness will be $r(a+2\sqrt{ab}+b)$, whereas experiment shows it $r(a+b)$,—combined brightness=sum of separate brightnesses. Consequently, fusion occurs *after squaring* (of C), after emergence of sensation. Whence, white light is the fused colors minus the color components. But the only

way content becomes suppressed is via optimum-plasticity (or lapse) reduction. "Minus the color components," means, then, I take it, that at a certain point in the rotation, route becomes so deflected that the intermingled stimulus-waves come to impinge upon optimum-interference orbit-forms, arisen in evolution like other adaptations, by accumulation of haphazard adaptive variations,—in the present case, variations in the plasticity-interrelation (93), accumulated in consequence of biological necessity for contrast-background in correspondence with that admixture of lights which happened most constantly to obtain in environment. Also, that white light actually results from simultaneous appreciation of colors, follows from the fact that the colors dispersed by a prism, re-collected by a lens so as to fall simultaneously upon the same retinal area, are seen as white. And that the fusion is central, is further corroborated by the existence of binocular color mixture.

Spencer's contention as to musical tone, seems matter of legitimate hypothesis, for (1) we cannot believe any physiologist will endorse over his signature, the distinction sought to be drawn between "cells" and "fibres." *In normal function* all we know about the activity of fibres, is what we see their terminal connections do, and with afferent nerves, what happens at the terminal of the reflex arc. Upon galvanization of the proximal end of a *cut* afferent nerve, cells become paralyzed sooner than fibres, but this *exhaustion phenomenon* is no warrant for assertion that in normal function, cells and fibres stand on a different plane. And available evidence (much of it come up since James wrote) goes to show that functionally, as anatomically, cell and fibre form a unit (neurone).

(2) The tone end-result differs *no more* from its asserted components, than white light from its color components.

(3) Though here quantitative measurements are as yet lacking, the fact that Fechner's logarithmic formula applies to audition as to vision, suggests that when they shall be available, the quantitative argument above applying in the case of color-white fusion, will apply equally in that of noise-tone fusion.

(4) More intermediate terms exist in the noise tone than in the color-white series, every saw-mill affording numerous transitions from undoubted noise through various gradations of buzzing and humming, at least nearly up to musical tone.

(5) It is corollary from the present theory, that "integration" does not take place between periphery and sensation area.

"Did each neural shock give rise to its own psychic shock and the psychic shocks then combine, it would be impossible to understand why severing one part of the central nervous system from another should break up the integrity of the consciousness. The cut has nothing to do with the psychic world. The atoms of mind-stuff ought to float off from the nerve-matter on either side of it and come together over it and fuse, just as well as if it had not been made" (I, 157).

Comment.—Consciousness is *as* immanent in the neurone, as nerve energy and resistance, and no more than they, ought it to "float off" from the nerve matter.

Thesis.—Self-compounding of mental states is "logically unintelligible," leaving out the essential feature of all "combinations" we actu-

ally know, that they are effects wrought by the units "combined," upon some "entity" other than themselves.

This *invincible contention* of the spiritualists against the associationists in psychology, has never been answered by the latter. No "forces, material particles *or mental elements,* can sum themselves together. Each remains, in the sum, what it always was; and the sum itself exists only . . . in the shape of some other effect on an *entity* external to the sum itself. . . . In the parallelogram of forces, the 'forces' do not themselves combine into the diagonal resultant; a body is needed on which they may impinge, to exhibit their resultant effects. No more do musical sounds combine *per se* into concords or discords. These are names for their combined effects" on the ear. 'On the whole, tendons are to muscular fibres, and bones are to tendons, combining recipients of mechanical energies. A medium of composition is indispensable to the summation of mechanical energies' (I, 158),—italics ours.

Comment.—So far, assertions are correct ("true") by reason of being mere ascertained verifiable matter of fact. From here on, however, the argument is mostly logical-metaphysical, not psychologic-evidential. Note the metaphysical term, "entity," here introduced into a discussion on mechanics instead of the natural term *substrate,* for no obvious reason than that which ultimately transpires.

Thesis.—Where the units "combined" are mental states, the case is in no wise altered.

Shuffle 100 feelings "and pack them as close together as you can (whatever that may mean); still each remains the same feeling it always was, shut in its own skin, windowless, ignorant of what the other feelings are and mean. There would be a 101st feeling there, if, when a group or series of such feelings were set up, a consciousness belonging to the group as such should emerge." Associationists say mind is constituted by a multiplicity of distinct 'ideas' associated into a unity. There is, they say, an idea of a + one of b, therefore an idea of $a + b$, whereas the last is not identical with the former two. "It is one, they are two; in it, what knows a also knows b; in them, what knows a is expressly posited as not knowing b; etc. In short, the two separate ideas can never by any logic be made to figure as one and the same thing as the 'associated' idea. This is what the spiritualists keep saying; and since we do, as a matter of fact, have the 'compounded' idea, and know a and b together, they adopt a farther hypothesis. *The seperate ideas exist, they say, but affect a third entity, the soul. This* has the 'compounded' idea, . . . an altogether new psychic fact to which the separate ideas stand in the relation, not of constituents but of occasions of production." And since states of mind which know many things together do exist, they must exist as single new facts, effects, possibly on the Soul, but at any rate independent and integral, and not composed of psychic atoms (I, 161, 162),—italics ours.

Comment.—Here, all credit accrued to "entity" through its use instead of substrate, is transferred by sheer force of dictum ("the case is in no wise altered") to a category of which it has never been ascertained to be empirical fact, in a discussion purely one of verbal logic. The *real* question, what material substrate exists and suffices for fusion of ideas, is not asked.

Thesis.—The minimal mental fact, is the "entire thought."

The facts of auditory and of optic aphasia, show "the whole brain must act together if certain thoughts are to occur. . . . The consciousness, which is itself *an integral thing not made of parts,* 'corresponds' to the *entire activity of the brain,* whatever that may be, at the moment. This . . . . expresses the *bare phenomenal fact with no hypothesis.* . . . Our own formula escapes the unintelligibility of psychic atoms by taking the *entire thought* (even of a complex object) *as the minimum with which it deals on the mental side.* But in taking the *entire brain-process* as its minimal fact on the material side it confronts other difficulties almost as bad." It ignores analogies between the composition of the total brain-process and that of the object of the thought. The former is com-

posed of parts, simultaneous processes in the seeing, hearing, feeling, and other centers; the latter also of parts, seen, heard, touched, muscularly manipulated. 'How, then, should the thought not itself be composed of parts, each the counterpart of a part of the object, and *of a part of the brain-process?*' (I, 176-178), —italics ours.

Comment.—The facts of optic and of auditory aphasia being among the buttresses of brain-localization (a first fruit of which is compositeness of mental states), *just which* facts show "the whole brain" must act together in any sense other than *synchronously?*

The "entire thought" does *not* correspond to the "entire activity of the brain," not if that mean only: Of the psychogenous portion. The activity even of that portion includes more than the thought, covering at least also process corresponding to values representing optimum-plasticity (or lapse) reduction ("automatic action").

But, as used, the phrase "entire thought" is *devoid of meaning.* I sat about three minutes with light from a moderately illuminated wall coming through closed lids, observing; repeatedly there emerged as, and receded from the consciousness, cock-crows, dog-barks, occasional roar of train and rattle of wagon, sounds of footsteps, of music, of door slammed, etc. *Just what,* now, was the "entire thought,"—the three-minute or each sigma consciousness? If one but take the "moment" short enough, the affirmative of non-compositeness of mental states, may rise to: Introspection affords no indication of compositeness,—which if taken *au serieux* as evidence, is the fallacy on p. 2, above. But what of the *serial* consciousness?

CLASSIFICATION OF MENTAL STATES.

These are classifiable in two ways, by different criteria and canons of evidence.

Classification upon data accessible via introspection:
As *single* or *plural.*
Classification upon data not accessible via introspection:
Single states are { *simple* / *composite*

Single and plural mental states.—An *individual* or *single* state is (1) preceded by a different state, and followed by a different state; and is (2) with respect to concurrent states, an *independent variable* (in duration, intensity, "quality"). Example: Green from non-rotating, and "continuous" green from rotating quadrant.

"Single" does not exclude the state from being serial fusion-product; most single states are such product. Single is, in fact, defined in a somewhat wide, loose, vague, *useful* way. In strictness, it should refer only to the mental units (*proximate* elements), the *briefest* states appreciable ("instantaneous" flash of light). But, then, it would have little applicability, these units occupying a minimal place in the complicated human mentality. Indeed, single is often used in a wider sense still. I called my three-minute "train of thought," *"one"* (single), because (1) my attention became focused upon the *constant* in the situation (unvaryingly illuminated wall), and (2) nothing happened startling enough to shift attention from it. But, these wider, looser, vaguer uses do not impeach, but presuppose the preciser conception, and are, indeed, permissible only so long as it is realized

that they *are* wider, looser and vaguer, looser and vaguer from the preciser basis, and that they can at any time be re-precised down to that basis through shift of introspective attention to the lesser and truer singles of the plurality.

Again, what is an individual, depends upon the point of, and the object in view. Had I been intent upon counting clock-ticks, I should have called my state as many as tick no-tick, tick no-tick, made it.

In the accustomed wide sense, "single" has nothing to do with uniformity so long as variation is not wide enough in time brief enough to amount to introduction of a state perceptibly different. I call the whistle of a locomotive dashing past, "one" whistle, neglecting its crescendo and descendo in pitch; but the whistle of some steamboats which, fairly uniform for several seconds, *abruptly* alters pitch to a practical discontinuity ("shriek"), I call one or many,—one, to query, How many whistles; several, to query, How many sounds recognizable? But these are the *ordinary* difficulties of the problem of individuality.

Simple and composite mental states.—A *simple* state is one not demonstrably made up of lesser states. Example: Pure color tone. A *composite* state is one demonstrably made up of lesser states; its characters are a function of its components and the interference-reduction involved. Example: White light.

Most important to realize is that as to simple or composite *introspection affords no data.* That white light is, *e. g.,* composite, introspection no more indicates than it does existence of brain. This is intelligible from the conditions involved. Equally with other consciousness, introspection is *nothing but* the sum of the consciousness-values, and, in the present case, of psychosis part-content and relational part-content. And one witnessing under his eyes transformation of complementary colors, would pronounce the resulting white "single, composite,"—"single," because introspectio comes to contain, along with the psychosis part-content *white,* relational part-content expressive of difference of that white from the preceding psychosis-state (to contain individuality-marking content, *i. e.*); "composite," because he *actually witnessed the genesis* out of the *already-emerged* colors, of the white. But one arriving first after fusion had become complete, might say "single, *simple,*" the latter being unwarranted. For, as fact, relational content expressive of difference emerges in introspectio, only in association with two (or more) psychosis-values. But here white stands alone (without contrast). Whence, no difference-marking content (other than individuality-marking) will emerge. Conseqently, no evidence accrues from introspective observation of the fusion-product, as to its *composition.*

Equally important is it to realize that simple is defined in a wider, looser, vaguer sense; that were it defined in strictness, it would have no usefulness; that it *is* useful in the sense of *proximately* simple or *simpler;* and that it denotes neither "atoms of consciousness," nor the mental units to whose serial fusion practically all other states are due. But even these "units," the last stage to which introspection can resolve content, are sometimes already composite (instantaneous flash of white light).

Unable to decide just where in my three-minute train of thought, lay the "entire thought," evidence shows the "thought" not entire. I called the cock-crow "one," because not divided up by no-crow intervals. But that it was not *really* one whole, follows from (1) its different parts differing in pitch, for how can the same sensation be of one pitch and also of another; (2) its not waiting till the cock had done and then coming all as one mass, but coming as a progression, which means a *succession;* (3) my ability to fractionate it by scaring the cock, thereby losing any undesired remainder. The only rational explanation is that vibrations of the cock's vocal cords initiate innumerable air-pulses which undergo reduction in number through adaptive inertia of the sense-organ[10] to a series representative of environment, which series is followed by emergence of sensation-fractions succeeding one the other so rapidly as to fuse to a "continuous" crow.

RELATION BETWEEN SUCCESSIVE MENTAL STATES.

It is conspicuous merit in the "automaton theory" that it involves the consequence that "feelings not causing nerve-actions, cannot even cause each other" (I, 133).

Hypothesis.—Each mental state arises only in consequence of ("is caused by") a preceding state.
Hypothesis.—Each mental state arises independently from the nervous rhizome.
Hypothesis.—Some mental states arise only in consequence of preceding states; some arise independently from the nervous rhizome.

In the third, the original question recurs as to the first class of cases. The first is negatived by (1) the impossibility of understanding how, upon that hypothesis, consciousness ever rose in the phylogeny, and how it arises in the ontogeny; and (2) the fact that sensations never "cause each other," for, though I have experienced countless flashes of light, I have never seen a second (third, etc.) flash follow from the first, subsequent flashes occurring only sequent to subsequent stimulation. Whence, the relation between successive states is the indirect relation between successive upshoots from a common rhizome, as with the *Polygonatum* flower-series, the members in which lack serial interconnection, yet form a congruous series, the congruity being a function of community of origin.

What are, now, the actual relations involved in a (*e. g.,* my three-minute) train of thought. Summing results:—

1. The consciousness occurs not in one mass but has a jointed structure (geologically speaking), the successive portions sustaining one to another the relation not of metameres but of serial sections, the corresponding portions in the successive consciousness-sections yielding a "construct" (cock-crow) comparable with the embryologic reconstruction of an organ.
2. The relation obtaining among states persisting for many sigmas, is the *no*-relation of *independent concurrence,* the states continuing side by side (so to speak), without mutual influence,—qualified by the

[10]Each light wave lasts approximately one-half quardrillionth of a second, an exposure of the retina too brief to evoke sensation; and many waves (billions) heap their effects before potential reaches the point of arousing the adaptively sluggish sense-organ.

possibility at any sigma, of alteration in the previously existent inter-proportions, through one state vivifying at expense of its concurrents to the point of monopolizing the fovea centralis of the consciousness-retina known as "attention."

3. The relation obtaining among states coexisting at any sigma, is the *no*-relation of *independent concomitance.*

4. The congruity of the consciousness is mainly serial; what states coexist, is mere matter of happening, and unhabitual combinations of coexistents furnish many of the "surprises" of life.

Juxtaposing of mental units into states and of states into trains of thought, is entirely serial, each unit jointing on to its predecessor and its successor on to it, whereby results a number of pseudo-continuities, mutually unrelated except as any two (or more) co-existents may happen to be co-successors to a common forerunner. And 2 and 3 mean that mental content is the expression of the activities of independently excited and concurrently active sensori-motor arcs, the several activities standing in the relation of competitors for monopoly of the brain-energies toward response to the most urgent happening of the moment.

5. For its congruity, consciousness is dependent upon nervous congruity. Each successive fraction of the cock-crow, becomes adjoined to the preceding fraction *of the crow* and not to that of the music, because identity (or closest similarity) of wave-values entails identity of route and discharge on to identical (or closely approximate) neurones *en route* to discharge on to related muscles.

Congruity of "association" is likewise a function of optimum motor response via *Rückwirkung,* such response coming about only as a sequel to the conduction-readjustments in chapter II, which, summing to environment-parallelism, involve environment-parallelism in the emerging consciousness, which parallelism *is* congruity (accustomedness).

THE BRAIN-UNIT IN MENTAL ACTIVITY.

Thesis.—"Entire brain" is not a physical fact; the molecules are the only physical fact, but are composed of atoms, whence we are thrown back on to the atom and its consciousness.

"The only realities are the separate molecules, *or at most the cells.* . . . The cell is no more a unit, materially considered, than the total brain is a unit." It is composed of molecules, and these in turn of atoms. The multiple-monad theory, therefore, "must set up for its elementary and irreducible psychophysic couple, not the cell and its conciousness, but the primordial and eternal atom and its consciousness" (I, 178, 180),—italics curs.

Comment.—The cell is not a unity; it is an aggregate, *ultimately* of atoms but *proximately* of structures and "cell-elements" (centrosomes, microsomes, linin, chromatin) which, possessed of specific dynamic values, behave like things,—the centrosomes being, *e. g.,* directive for mitosis. But with the chromatin *in forma* chromosomes, we are hardly confined to presumptions, many facts supporting the view that these bodies are the substrate via which unit-characters pass from parent to offspring. This would, however, mean that (1) in offspring-embryogeny those bodies pass through the same character-endowing critical-sequence cycle as in parent-embryogeny the parent-formative chromosomes passed through, and (2) they *arrive at the same end-result* (same unit-character). But then, their thing-nature is proven. And no evidence showing brain-cells on any plane different

from other cells, the unit in brain-activity is indicated as *proximate* not ultimate.

WHAT CONSTITUTES SUFFICIENT FUSION-SUBSTRATE?

Thesis.—For fusion of "ideas" to a "compounded" idea, nothing but pontifical cell will suffice, which cannot be found, whence we are thrown back on to the Soul as the only available "entity" whereby given "idea of *a*" + "idea of *b*," to get "idea of *a* + *b*."

In the multiple-monad theory, "every brain-cell has its own individual consciousness which no other cell knows anything about. . . . There is, however, among the cells one central or pontifical one to which *our* consciousness is attached. But the events of all the other cells physically influence this arch-cell; and through producing their joint effects on it, these other cells may be said to 'combine.' . . . The physical modifications of the arch-cell thus form a sequence of results in the production whereof every other cell has a share. . . . And similarly, the conscious correlates to these physical modifications form a sequence of thoughts or feelings, each one of which is, as to its substantive being, an integral and uncompounded psychic thing, but each one of which may (in the exercise of its *cognitive* function) be *aware of* things many and complicated in proportion to the number of other cells that have helped to modify the central cell." But "there is no cell or group of cells in the brain of such anatomical or functional preeminence as to appear to be the keystone or center of gravity of the entire system" (I, 179, 180).

Comment.—We accept James's canon that "One must be impartially *naif* or impartially critical" (I, 137), and *either* all fusion (especially superfusion) substrate is "pontifical cell" (millions of them), or else there is *none,* in which case there is *no* fusion "in the nerve-world," and the Soul must be requisitioned for *all* fusion, of noise to tone as of ideas to compounded idea,—unless the cases be shown to differ.

"All the arguments for a 'pontifical cell' or an 'arch-monad,' are also arguments for that *well known* spiritual agent in which *scholastic psychology and commonsense* have always believed. . . . *If there be* such entities as Souls in the universe, they *may possibly be* affected by the manifold occurrences that go on in the nervous centers. To the *state of the entire brain at a given moment* they *may* respond by inward modifications of their own. These changes of state *may be* pulses of consciousness, cognitive of objects few or many, simple or complex. The Soul *would be* thus a medium upon which . . . the manifold *brain-processes* combine their effects. . . . And as its pulses of consciousness *are unitary and integral from the outset,* we escape the absurdity of supposing feelings which exist separately and then 'fuse together' by themselves. . . . To posit a soul influenced in some mysterious way by the brain-states and responding to them by conscious affections of its own, seems to me the line of least logical resistance, so far as we yet have attained. If it *does not strictly explain anything,* it is at any rate less positively objectionable than either mind-stuff or a material-monad creed" (I, 181, 182),—italics ours.

Comment.—We are in *Subjunctive Land* far from scientific territory. (1) There *may be* Souls; (2) these *may be* affected by brain-processes; (3) they *may* respond; (4) the response *may be* pulses of consciousness; (5) the pulses *may be* unitary and integral; (6) the Soul *may be* capable of acting as fusion-substrate,—"the possibilities of may-be seem to me infinite" (Huxley).

But the conception of an "entire thought" which corresponds to the "state of the entire brain at a given moment," contains self-stultifying consequences. Even allowing my state unitary for as many consecutive sigmas as illumination persisted *alone,* with advent of music commenced a separate (illumination-music—*IM*) brain-state,

—not, however, *one* such state, but at least as many as J. N. D's in the pitch crescendo-descendo, as many as Corti fibres thrown into action. During this *IM* series of brain-states, came cock-crow. But infinity of adverse chances precluding coincidence of crow-rhythm with music-rhythm, the *IM* brain-state series became further fractionated,—*IMeCa, IMeCb, IMfCb, IMfCc, IMgCc, IMgCd,* etc.). And with advent of rattle of wagon, the *IMC* brain-state series became still further fractionated, to well-nigh unwritable formula. Whence the "given moment" at which the state of the brain is "entire," cannot be a minute-, or a second-, but must approximate the sigma-moment. And James's theory requiring an "entire thought" for each separate brain-state, the entire thought approximates the sigma-consciousness. On what criteria can this be pronounced simple or composite? If one is uncertain in a single embryologic section whether a cell mass represents one organ or two organs, comparison with sections taken at later developmental stages, shows the mass either (1) to remain a mass of co-variables, or (2) to become resolved into two masses which with respect to each other behave as *independent variables.* Applying this test, cock-crow ceases independently of music, music independently of illumination,—all independent variables. Whence, the sigma consciousness is a cross-section of independent concurrents.

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SUMMARY.

The current phase of the penultimate universe (cosmos-fraction—1 or 99%—accessible to us) sums to: Energy-trend from a high-heat pole to a low-heat pole ("absolute zero"). Complementary to this energy-dissipation, are: (1) Substance-*integration* to "matter" in its various molecule-types, constituting *evolution* (inorganic and organic); (2) matter *aggregation* to sidereal and solar systems and masses generally, constituting *contraction* (when *discontinuous,* "gravitation"). Bodies (molecule-types) fall into two classes,—a *general* class forming with liberation of heat; a *special* class forming with absorption of heat. The latter comprises (1) an explosive type, seemingly dominated by the nitrogen component; (2) a "living" type, dominated by the carbon component.

Genetic-ness (origin via identity of critical sequence) dates *ab initio.* Starting from electron-homogeneity, the penultimate universe has arisen by *discontinuous* evolution, bodies emerging successively and intermittently as cosmos-temperature came to decline below their critical dissociation-points. Where determinable, the process involves *unification of multiples* (electrons to atom, atoms to molecule). This *integration,* alike, equally and synchronously of properties and structure, comes about via critical sequence. Properties and structure are a function not of properties and structure of constituents alone, but *equally of all factors entering into the formative sequence.* The resulting body is qualitatively incommensurate with its constituents; it emerges suddenly. Sudden emergence of qualitative incommensurateness, then, proves a condition a new order of being only if accompanied by proof that the condition is not of the critical order. And not antedating the critical conditions, critical phenomena are

factors not present *ab initio* but emerging at critical junctures along the evolutionary route, without their emergence constituting infraction of the course of nature.

But *why* critical sequences? All universe-change is toward maximum densification (integration + aggregation) of substance and dissipation of energy (whither, we know not). With declining temperature, a point comes at and below which two (or more) bodies previously densifying *ad maximum, separately,* densify *ad maximum* only *together,*—"dissociation-point;" change there occurring, combination critical sequence. *Proof*: Combination below this point (of CaO and H_2O, *e.g.*), occurs with *additional* densification (evidenced by heat-liberation). For most bodies this neutral point lies far above present temperature; but bodies combining with absorption of heat, behave like bodies above their neutral point,—that they densify *ad maximum, separately,* is evidenced by heat-liberation upon their separation. And this exceptional combination-type is explicable between two hypotheses, both seemingly little more than re-statements of the facts,—(1) the constituent bodies "somehow" hamper each other's heat-liberation; (2) the sub-universal increment-to-increment association between heat-liberation and densification, is susceptible, *exceptionally and temporarily,* of disjunction. But then, heat-accumulation might ensue, densification nevertheless progressing, possibly in connection with surrounding freezing mixtures. Result: Growing stress, obviously with a limit, beyond which further densification is impossible, *separately.* But just the fact of combination, indicates that further densification is possible, *together.* And, *de facto,* nitroglycerin densifies "normally" from combination down to its next critical point (freezing). Critical sequences are, thus, expressions of zigzagging of the densification-lines, everywhere descending the steepest slope.

Apparently the conscious and probably the living state, arose as critical phenomena. From an early prodigious prolificness, living-matter aggregates diverged along two dynamic lines,—the plant line marked by enormous expansion of surface, fixed habitus, and (retained) prodigious prolificness; the animal line by moderate expansion of surface, sufficing in association with active habitus sustained by emergence of structures (nervous system including cortico-mental action) admitting of profiting by experience.

"Living" matter exhibits a distinctive property, *plasticity* (73, 65)—capacity for undergoing on *mere transit through it* of energies, *alteration,* such that upon subsequent similar energy impacts, transit occurs more "advantageous" for the living-matter aggregate, than was the initial transit. Usually considered an "activity" of the living matter, plasticity is *as much* re-activity, as is retraction of stretched caoutchouc.

Some bodies originating via either identity or equivalence of sequence, living-matter aggregates (organisms) arise only via identity, because via identity ("heredity"), in matter possessed of plasticity, *summing of modifications* resulting from contact with environmental energies, comes about.

Equally with all other adaptation, cortico-mental adaptation has come about through readjustment via *Rückwirkung,*—a working back from more efficient motor response as starting point and constant basis for "selection." But response being a function of antecedent energy-conduction and energy-transformation conditions, Preponderant Survival of individuals opposing to environmental happening more efficient response, is, incidentally yet inevitably, Survival of those in which such antecedent conditions are more efficient (restate-

ment, efficiency of conditions finding measure only through ensuing response).

The factors determining direction of energy-flow through the nervous system at each moment, are: The fundamental constitution of that system in the particular species and individual; its imprintation-conditions ("past experience"); its intoxication condition (81). In the course of such flow comes into play the psychodynamic process (85) consisting in (1) emergence by crisis between nerve energy and nerve resistance, of "thermoid energy," which sustains to such energy and resistance a relation homologous, and a quantitative relation identical with the corresponding relations sustained by heat emerging in the electric circuit, to electric energy and resistance; and (2) reaction of the thermoid energy upon the nerve substrate, comparable with the resistance-reducing reaction of the heat upon the carbon conductor (65, 79). Thus is explained how (*a*) transit and motor response become more efficient, time after time; (*b*) thermoid energy is expended in intramolecular work involved in bringing about diminished resistance; (*c*) with progressively diminishing resistance, the amount of such energy emerging, progressively diminishes.

A simplest formula relates cortical to peripheral-environmental conditions,—thermoid energy is to energy falling upon unit-area of sensory surface, as 1 : 1.

In dependent relation with the foregoing biologic factor-sequence, readjustment comes about in the cortico-mental zone: Of conduction-conditions, in the thought zone via accumulation of haphazard adaptive variations *ad optimum* of the plasticity-aplasticity scale, in the feeling zone via accumulation of such variations *ad optimum* of the intoxicant activities; of transformation-conditions for both zones alike, via accumulation of haphazard adaptive variations *ad optimum* of the anabolic-catabolic balance of the neurone (energy-liberation substrate), an intoxication factor. In addition, in the individual lifetime, in plastic substrate, conduction-conditions undergo readjustment via "acquired" imprintation-refinement of graduation of resistance (profiting by experience). Whence, ontogenetic modifications sum to optimum lapse; phylogenetic, to optimum plasticity-aplasticity.

The net outcome of these complementary readjustments, is:—*Neurologically*: A myriad graduations of resistance, arising through (*a*) "selection" of optimum plasticity-aplasticity with (*b*) imprintation-refinement of graduation of this *Anlage,* and (*c*) "selection"-graduation of the intoxicant activities; and a myriad graduations of energy-liberation through "selection"-graduation of the anabolic-catabolic balance,—the whole summing, *neurodynamically,* to a myriad values for r and C, and *physiologically,* to organization of function in the cortico-mental zone.

As in cortico-mental action there is but one *process* (the psychodynamic), there is but one *content,* consciousness, in one of three facies in dependence upon substrate conditions,—*sensations,* whose vividness is a function of intensity of stimulus, which do not lapse, and which yield data (dynamic values) for space orientation; *feelings,* whose vividness is a function of the intoxication-conditions, which do not lapse but fade (85 note 2), and accentuate or minimize reaction; *thoughts,* whose vividness is (values of C being constant) a function of the extent of interference-reduction, and which lapse *en route* to profiting by experience.

A simplest formula relates sensation (inferentially all consciousness) to thermoid energy,—they are correlated *increment-for-increment,* and the condition of emergence of sensation (inferentially all conscious-

ness) is a certain ("limen") value of that energy. But increment-to-increment correlation for thought, explains *how* "mind" acts on body, *how* thought ("consciousness" of common parlance) satisfies the conservation of energy, and *how* repetition of action involves lapse,—for, transferring to thought itself the above fluctuating values of its increment-to-increment correlate, it becomes evident that (*a*) "action" of consciousness is re-action, resistance reducing and graduating; (*b*) consciousness has no *trend,* but is expended *in situ* in intramolecular work; (*c*) in dependence upon progressive diminution in thermoid energy, it lapses.

Consciousness is known as are all things, in consciousness,—here, in introspectio. But many things introspectio does not reveal, among them compoundness of mental states. Yet such compoundness follows from break-down of counter-arguments (especially that for correlation of "entire thought" with "entire activity" of brain); non-consideration hitherto of results of fusion with coincident interference-reduction; the facts of brain-localization and those indicating that each mental state exists not for its mental *quale* but for therewith correlated dynamic values; the fact that "continuous" states prove to be serial fusion-product; lack of interdependence of sucessive, and independent variability of concurrent states.

Penultimate versus Ultimate Philosophy.—The former knows no *ad infinitum;* at most, *ad indefinitum* which may become *ad definitum* merely. Not tracing a *logical* "chain of causation" to a First Cause *powerfull*[11] enough to account for all "effects," this philosophy gropes back for the first sequence. This it may any day find, when its backward task is done. For, if the electrons prove ether-derivatives, and no need transpire for assuming any substratum more primordial than the ether, then, all substances will be related back to final grounding in the ether; and water be defined, *e. g.,* as: A substance removed four critical sequences (supposing ether-electron one sequence) from the ether, possessed of (such and such properties).

No more than science itself, has its philosophy concern with propaganda or *-ism* (theism, spiritism, "ethics"); or share in creeds, such as "the universe *must be* one." *Is* the universe one or many? Whatever the probability of a unitary universe, that probability arises from (1) break-down of attempted distinction of categories; and (2) presumption that the electrons will prove ether-derivatives. But that presumption is no necessary part of Penultimate Philosophy which grows backward only by accretion of newly discovered fact. And the primordium is ever its limit because there applicability of its methodology ceases.

Toward *formulation* of the problem of being, this philosophy contributes: No need exists by reason of any psychophilosophic fact, for asserting that problem other than unitary, no evidence showing the mystery of consciousness distinct from the mystery of matter-energy.

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[11]Cause (that which initiates the change whose outcome is the effect), is either the final determinant, or the whole left side of

$$dv\mathrm{H}_2 + dv\mathrm{O} + dv\mathrm{h} = dv\mathrm{H}_2\mathrm{O} + dv\mathrm{eh}$$

where *dv* is dynamic values; h, heat necessary to initiate combination; eh, evolved "heat of combination." If the latter, "cause" is easily misunderstood, harmless platitude; and the doctrine, "Effects imply *sufficient* causes," the same. But if the final determinant, then magnitude of cause bears no relation to that of effect, and the doctrine, "*An* effect implies *a* sufficient cause," is the most vicious notion of: Antecedent *with power to accomplish* (*necessity* of effect following, and what not), instead of empirical sequence within the limits (temporal and spatial) of our observation.